April 10, and will be open to all undergraduates of Cambridge and Oxford, and to persons under twenty who are not members of the Universities. Further information may be obtained from the Rev. E. Blore, Tutor of Trinity College.

ST. JOHN'S COLLEGE.—One of the value of 50*l.* per annum. The examination (in Chemistry, Physics, and Physiology, with Geology, Anatomy and Botany) will be in December, and will be open to all persons who have not completed a term of residence at the University, as well as to all who have entered and not completed one term of residence. Natural Science is made one of the subjects of the college examination of its students at the end of the academical year, in May; and Exhibitions and Foundation Scholarships will be awarded to students who show an amount of knowledge equivalent to that which in classics or mathematics usually gains an Exhibition or Scholarship in the college. In short, natural science is on the same footing with classics and mathematics, both as regards teaching and rewards.

CHRIST'S COLLEGE.—One or more, in value from 30*l.* to 70*l.*, according to the number and merits of the candidates, tenable for three-and-a-half years, and for three years longer by those who reside during that period at the college. The examination will be on March 24, and will be open to the undergraduates of the college, to non-collegiate undergraduates of Cambridge, to all undergraduates of Oxford, and to any students who are not members of either University. The candidates may select their own subjects for examination. There are other Exhibitions which are distributed annually among the most deserving students of the college. Further information may be obtained of Mr. John Peile, Tutor of the College.

GONVILLE AND CAIUS COLLEGE.—One of the value of 60*l.* per annum. The examination will be on March 24, in Chemistry and Experimental Physics, Zoology, with Comparative Anatomy and Physiology, and Botany, with Vegetable Anatomy and Physiology; it will be open to students who have not commenced residence in the University. There is no limitation as to age.—Scholarships of the value of 20*l.* each, or more if the candidates are unusually good, are offered, for Anatomy and Physiology, to members of the College.—Gentlemen elected to the Tancred Medical Studentship are required to enter at this College; these Studentships are five in number, and the annual value of each is 100*l.* Information respecting these may be obtained from Mr. B. J. L. Frere, 28, Lincoln's Inn Fields, London.

CLARE COLLEGE.—One of the value of 60*l.* per annum, tenable for two years at least. The examination (in Chemistry, Chemical Physics, Comparative Anatomy and Physiology, Botany with Vegetable and Animal Physiology, and Geology) will be on March 24, and will be open to students intending to begin residence in October.

DOWNING COLLEGE.—One or more of the value of 40*l.* per annum. The examination (in Chemistry, Comparative Anatomy, and Physiology) will be early in April, and will be open to all students not members of the University, as well as to all undergraduates in their first term.

SIDNEY COLLEGE.—Two of the value of 40*l.* per annum. The examination (in Heat, Electricity, Chemistry, Geology, Zoology and Physiology, Botany) will be on March 24, and will be open to all students who intend to commence residence in October.

EMMANUEL COLLEGE.—One of the value of 70*l.* The examination on March 24 will be open to students who have not commenced residence.

PEMBROKE COLLEGE.—One or more of the value of 20*l.* to 60*l.*, according to merit. The examination in June, in Chemistry, Physics, and other subjects, will be open to students under 20 years of age.

KING'S COLLEGE.—One of the value of about 80*l.* per annum. The examination, on April 14, will be open to all candidates under 20, and to undergraduates of the college in their first and second year. There will be an examination in elementary Classics and Mathematics, in addition to three or more papers in Natural Science, including Physics, Chemistry, and Physiology.

Although several subjects for examination are in each instance given, this is rather to afford the option of one or more to the candidates than to induce them to present a superficial knowledge of several. Indeed, it is expressly stated by some of the colleges that good clear knowledge of one or two subjects will be more esteemed than a general knowledge of several.

Candidates, especially those who are not members of the University, will, in most instances, be required to show a fair knowledge of Classics and Mathematics, such, for example, as would enable them to pass the previous examination.

There is no restriction on the ground of religious denominations in the case of these or any of the Scholarships or Exhibitions in the Colleges or in the University.

Further information may be obtained from the Tutors of the respective Colleges; and the names, with certificates of character, date of birth, &c., must be sent to the Tutor of the College, in each case, several days before the examination.

It will be observed that in several instances the time of the examination is the same, certain of the Colleges having combined together so as to hold one or two examinations instead of each College holding a separate examination.

Some of the Colleges do not restrict themselves to the number of Scholarships here mentioned, but will give additional Scholarships if candidates of superior merit present themselves; and other Colleges than those here mentioned, though they do not offer Scholarships, are in the habit of rewarding deserving students of Natural Science.

It may be added that Trinity College will give a Fellowship for Natural Science, once, at least, in three years: and that most of the Colleges are understood to be willing to award Fellowships for merit in Natural Science equivalent to that for which they are in the habit of giving them for Classics and Mathematics.

ASTRONOMICAL ALMANACS[*]

X.—*Remodelling of the "Nautical Almanac" and the "Jahrbuch."*

NEARLY all the reforms which concerned astronomy were realised by Encke in the *Jahrbuch* for 1830, which appeared in May 1828. The appearance of this volume created an enormous sensation in England. The contest between Young and his opponents was then at its height. Strengthened by the help which had come to it from Berlin, the Astronomical Society redoubled its complaints and renewed its action; but the death of Thomas Young (May 10, 1829) soon occurred to simplify matters. In order that the question might not be hastily decided, the Society got the *Nautical Almanac* provisionally entrusted to the care of the Astronomer-Royal, J. Pond; at the same time it appointed a commission of forty members, composed of the directors of all the observatories and the principal astronomers and mariners, English and foreign.[†]

At last, at its annual meeting in February 1830, the Society awarded to Encke its gold medal for the great service which he had rendered to astronomy. "It would be superfluous," said Sir James South, President of the Society, in the address which he gave on that occasion, "for us to enlarge upon the merit of this well-known work, which, beyond all rivalry, ought to be regarded as the only ephemeris on a level with the requirements of

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[*] Continued from p. 49.

[†] Struve took part in this commission.

Science, as the manual and guide of practical astronomy, wherever it may be cultivated."

But if the English are impartial and generous towards strangers, they could not bear to be for any time inferior in the various services which touch upon their interests. The sub-committee [*] charged with preparing the plan for reorganising the *Nautical Almanac*, presented its report to the Society at the meeting of November 19, 1830, a report which was adopted by the Council and immediately approved by the Admiralty. The results of this beneficial agitation were of immense value to astronomy and navigation, and the improvements introduced were such that, even from an astronomical point of view, the *Nautical Almanac* easily surpassed the *Jahrbuch*, and from a maritime stand-point it has not yet been equalled.

First of all, it should be stated that the Commissioners laid down as an absolute rule, a rule which has ever since been scrupulously followed, that the *Nautical Almanac* ought to appear four years in advance of the year for which it is calculated. Moreover, the direction of the *Nautical Almanac*, while continuing under the jurisdiction of the Admiralty, was entrusted thenceforth to a single person, the Superintendent of the *Nautical Almanac* Office.

The *Nautical Almanac* has been from that time in reality a special scientific institution, having its offices and its library established in a separate building. The salary of the superintendent was fixed at 500*l*., and the annual parliamentary allowance was made amply sufficient to permit of the employment of calculators numerous enough to insure the greatest possible accuracy in the results. The first superintendent of the *Nautical Almanac* office was Lieut. S. Strafford, well known for the part which he took in the publication of Baily's "Zodiacal Catalogue."

The first volume of the new almanac, the *Nautical Almanac and Astronomical Ephemeris for the Year* 1834, appeared in July 1833. It embodied *all* the reforms which we have already mentioned; it would therefore be useless to indicate its contents in detail. We shall content ourselves with adding, that all the calculations relative to the principal planets were made under the direction of Schumacher of Altona, and those relating to the telescopic planets by the celebrated Encke. Moreover, as it is absolutely essential that a single list of stars of the moon should suffice navigators of all nations, the Royal Society came to an understanding with Encke on this subject. The stars of the moon ("moon's culminating stars"), ceased from that time to figure in the *Jahrbuch*, and the *Nautical Almanac* obtained the monopoly of this useful publication, a monopoly which it has since preserved.

The tables employed were nearly the same in the *Jahrbuch* and the *Nautical Almanac*. For the sun there were the new tables of Carlini, with the corrections of Encke and Bessel; for the moon the tables of Burckhardt; for Mercury, Venus, and Mars, the tables of Von Lindenau, with the corrections of Schumacher; for Jupiter, Saturn, and Uranus, the tables of Bouvart; for the satellites of Jupiter, the new tables of Delambre, with the corrections of Jenkins and Woolhouse.

XI. *The "Connaissance des Temps" since* 1832.

While this great work of reform and renovation was being carried on, the Bureau des Longitudes of France did not remain inactive. "The Bureau have recently appointed a commission, chosen from its own members, to examine some modifications which it would be expedient to introduce into the *Connaissance des Temps*. In considering this object, the commission has not lost sight of the fact that it is dealing with a work specially designed for mariners, with which they have been familiar for many years, and of which it was, above all, desirable that the price should not be increased." [*]

On the one side maritime necessities required that the *Connaissance des Temps* should, like the *Nautical Almanac*, appear four years in advance; although for long it has been published on an average only a year and a half before its date, being a delay of two years and a half. On the other side, the ephemeris then published by the *Connaissance des Temps* was evidently insufficient for French astronomers; the following modifications were therefore adopted, and were completely embodied in the *Connaissance des Temps* for 1835.

The mean time was the only time used (although astronomers needed the equatorial co-ordinates of the sun for true noon); the co-ordinates expressed in time were given at $0^{s}\cdot 01$, and those in arc, $0''\cdot 1$; the latitude and longitude of the moon were given for midnight and noon of each day; to the lunar distance were added those of the planets Venus, Mars, Jupiter, and Saturn; lastly were given for every tenth day, the apparent positions of sixty-four fundamental stars (the *Nautical Almanac* gave 100).

On the other hand, as it came to be seen that the solar tables of Delambre were defective, the Bureau invited Savary to amend them, but all he did was to remedy errors here and there by means of the corrections of Bessel. Moreover, Delambre's tables of satellites having been discontinued till 1840, Damoiseau was ordered to continue them. But all this was so insufficient, that the *Connaissance des Temps* could not be more serviceable to astronomers.

Thus, in 1838, the positions of the planets, which were given until then for every tenth day, were calculated to a minute of time and of arc; every third day for Mercury; every sixth day for Venus and Mars; every seventh day for Jupiter; every tenth day for Saturn; every fifteenth day for Uranus; and the value of the radius vector was added to the other elements. This was very far behind the *Nautical Almanac*, which gave the positions for every day to $0^{s}\cdot 01$ and $0''\cdot 1$.

In 1849, the number of fundamental stars whose apparent positions were given was carried to 115, and the apparent position of α Ursæ Minoris, was given for every day in the year. The *Nautical Almanac* had given those of α and δ Ursæ Minoris for 1834.

In 1854, M. Mathieu was specially appointed to the editorship of the *Connaissance des Temps*. Very soon after he entered upon his duties he had to sustain an attack which recalls that already referred to between Young, Baily, and Sir James South. For some years a sharp controversy was maintained between M. Mathieu and M. Leverrier, and at length the *Connaissance des Temps* of 1862 published for the first time the positions of the moon for every hour, with the differences for 10 minutes. "This innovation," the learned editor said, "is valuable to mariners; it simplifies the calculations of interpolation, and now sailors will be able to make use of the ephemeris of the moon with as much ease as that of the sun." The calculations of the moon are, moreover, made according to the tables of M. Hansen,[†] which the *Nautical Almanac* had employed since 1858. Lastly, in the same year, are given the positions of δ Ursæ Minoris for every day.

In the following year the ephemeris of the planets was improved, and there were given for every day the heliocentric and geocentric positions at mean noon of Mercury, Venus, Mars, Jupiter, and Saturn; for Uranus and Neptune the positions were calculated only for every fourth day. This was in imitation of a modification suggested by Mr. (now Sir G. B.) Airy to the superintendent of the *Nautical Almanac*, and applied by him from 1857 (*Almanac* for 1861). But, since 1839, besides the preceding information, the *Nautical Almanac* gave, first for every day, and from 1861 for every two days, the ephemerides of all the planets for the time of their passing the meridian of Greenwich, information which French astronomers would have been happy to find in the *Connaissance des Temps* for the meridian of Paris. Let us add, moreover, that the positions of Neptune were only given in the *Connaissance des Temps* in 1861 (for 1863), while they were in the *Nautical Almanac* from 1857 (for 1861).

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[*] Composed of Sir James South, president, F. Baily, reporter, C. Babbage, Capt. F. Beaufort, J. F. W. Herschel, J. Pond, Rev. Dr. Robinson, Lieut. S. Strafford, W. Struve.

[*] Advertisement of the *Connaissance des Temps* for 1832.

[†] "Tables of the moon constructed according to the Newtonian law of Universal Gravitation," by P. A. Hansen, Director of the Ducal Observatory of Gotha. (Printed at the expense of the British Government, 1857.)

It was also in this same year, 1863, that the *Connaissance des Temps* gave for the first time the values of the constants of Bessel, intended to transform into apparent positions the mean positions of the stars given by the catalogues; as well as the elements of the occultations, according to Bessel, in a form which enabled voyagers to calculate, for the very place where they happened to be, the principal circumstances of the phenomena. The *Nautical Almanac* had published all this since 1834.

In 1864, the positions of the sun, which for many years were calculated with the tables of Delambre, reconstructed in part by M. Mathieu, were published according to the tables of M. Leverrier; the same was done for the positions of Mercury, and in the following year for those of Venus and Mars. The *Nautical Almanac* had used the tables of M. Leverrier since 1860 for the sun and Mercury (*Almanac* for 1864), since 1861 for Venus (*Almanac* for 1865), since 1862 for Mars (*Almanac* for 1866). On the other hand, the *Connaissance des Temps* for 1864 appeared in February 1863, and consequently six months after the *Nautical Almanac* for 1866. Finally, the *Connaissance des Temps* for 1864 contained the rectilinear co-ordinates of the sun referred to the plane of the equator; they are found in the *Nautical Almanac* from 1849.

This collection of reforms raised considerably the value of the *Connaissance des Temps*, which, it was unanimously agreed, had fallen very low as compared with foreign ephemerides. The reform accomplished in France in 1864 was analogous to that of the *Jahrbuch* in 1829 and of the *Nautical Almanac* in 1830. But even at the present time the *Connaissance des Temps* does not contain any ephemeris of Ceres, of Pallas, of Juno, nor of Vesta, which has appeared in the *Nautical Almanac* and the *Jahrbuch* since 1830; nor of any of the numerous small planets discovered since 1845, for which the other two works publish a supplement each year. Yet for a long time past the continued observation of these telescopic planets has formed one of the most important occupations of most of the observatories.

In 1870 the direction of the *Connaissance des Temps* passed into the hands of Puiseux, who, however, kept it for only a very short time. His period of office, nevertheless, was marked by an important improvement. He indicated, by a figure in the proper place, the day on which, in consequence of the difference of length between the sidereal day and the mean solar day, each star passed twice across the superior meridian of Paris. This was a sad omission; such an indication is found in the *Nautical Almanac* for 1822.

At present the direction of the *Connaissance des Temps* is entrusted to M. Lœwy; Mr. Hind has been superintendent of the *Nautical Almanac* Office since 1853, and Herr Fœrster succeeded, in 1864, the celebrated Encke in the direction of the *Jahrbuch* of Berlin.

TELEGRAPHING EXTRAORDINARY

At the Telegraph Office, Washington, on Dec. 11, 1873, an experiment was carried out in the presence of Mr. Creswell, the Postmaster-General of the United States, the practical results of which will be of immense importance as regards the future of telegraphy throughout the world.

On that occasion the president's last annual message of 11,500 words was transmitted from Washington to New York, a distance of 290 miles, over a single wire in 22½ minutes, the speed obtained being over 2,500 letters per minute.

At New York the message was delivered from the automatic instrument printed in bold type in presence of the Postmaster of New York. This achievement in telegraphy is the more remarkable as the principle involved is not new, but was well known in 1848. The experiments made at that date were practically without result. By the new American combination of chemistry and mechanism the speed is apparently almost unlimited, messages at the rate of 1,200 words, or 6,000 letters, a minute being afterwards transmitted with equally satisfactory results.

Hitherto the speed attainable over circuits of similar length in this country by the Wheatstone automatic system, at present in use for the "high speed" service by the Postal Telegraph Department, does not exceed 200 letters a minute.

The new American instrument has a great advantage in the extreme simplicity of its construction, mechanical detail giving place to chemical action. One important result of this experiment is that it demonstrates that hitherto the speed of transmission of electric currents through a metallic conductor has been restricted from mechanical imperfections in the mechanism of the recording or receiving instrument, and that by the substitution of chemical decomposition for mechanical action, an almost unlimited speed of transmission may be obtained. It is to be hoped that this new transmitting and recording instrument may be the agent by which our present tariff of 1*s.* for twenty words, may be reduced to 6*d.*, or less, for a similar message. Scientific progress, practically applied, is an heirloom to a nation.

NOTES

Mr. Henry Lonsdale is preparing a biography of John Dalton, the great chemist, and would be glad of any letters or other aid in his important work.

At the meeting of the Paris Academy of Sciences held on Monday, January 5, M. Fremy was elected president for the ensuing year, and MM. Chasles and Decaisne were elected to serve on the central committee.

A committee, consisting of Lord Cathcart, Mr. C. Whitehead, Mr. Jabez Turner, Mr. Wakefield, Mr. Brandreth Gibbs, Mr. J. Bowen-Jones, Mr. W. Carruthers, F.L.S., and Mr. J. Algernon Clarke, appointed by the Royal Agricultural Society to carry into effect the suggestions of the judges of the potato disease essays held a meeting on Monday at Hanover Square. They will recommend the Council to offer three prizes of 100*l.* each for disease-proof potatoes. Competitors will probably be required to send in one ton of each variety by the middle of February. Each sample will be distributed among growers in many different parts of England, Wales, Scotland, and Ireland; and the produce of potatoes which resist disease during the first year's trial will be tested for two years longer. With a view of encouraging the production of new varieties, handsome prizes are to be offered also for disease-proof sorts raised from potato plums to enter into competition in the spring of 1879. The terms and conditions will be decided upon at the next meeting of the Council.

The Indian Museum, as it now stands, situated on the highest story of the India Office, has been found to be useless for all the purposes for which it was intended. It has therefore been resolved to erect on the plot of vacant ground in Charles-street, directly opposite the India Offices and facing St. James's Park, a new museum and public library. To this building,